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The principal purpose of this study was to estimate the concurrent validity of the pencil and paper "Minnesota Tests for Creative Thinking, Abbreviated Form VII" for identifying the creative abilities of eighth-grade students in industrial arts classes. Concomitant purposes were to investigate the relationships of creative abilities and (1) intelligence, and (2) school achievement. A definition of relative creative abilities in the industrial arts and guidelines for their measurement were developed and submitted to a sample of educational psychologists and industrial arts teachers to determine their acceptability. A procedure was selected for applying this to secure criterion measures of native abilities. Three pairs of industrial arts teachers were trained to rate a sample of 95 eighth-grade students. The "Minnesota Tests of Creative Thinking, Abbreviated Form VII" were administered. Verbal and non-verbal IQ tests, five standardized achievement tests, and eight sets of teachers' grades were analyzed, along with peer ratings. The abilities presented and measured by the Minnesota tests are inadequate to account for the creative output, but the test measures components not measured in the typical intelligence test. The fairly high relationship between substantive creativity and IQ appears to indicate that some of the convergent thinking abilities influence the production of unusual and useful ideas. (EM)

MEASURING CREATIVE ABILITIES IN JUNIOR HIGH SCHOOL INDUSTRIAL ARTS

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by

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A DIVISION OF THE AMERICAN INDUSTRIAL ARTS
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PREFACE

This is the second issue in a series of monographs being published by the American Council on Industrial Arts Teacher Education. These are produced and distributed as significant contributions and are submitted to and considered by the Publications Committee. A fixed schedule of publications has been avoided, thereby permitting several publications during one year or no issues depending upon availability of worthy contributions.

Among the primary sources of manuscripts are the ACIATE Committees who are working on problems facing industrial arts teacher education. When their findings are too extensive for presentation as a journal article or are of specific interest only to teacher educators, they may logically constitute the materials for a monograph.

The Publications Committee may, at their discretion, solicit manuscripts from ACIATE members or representatives from related disciplines. The Committee's primary objective will be to identify information, which when published and distributed, will advance the frontiers of industrial arts and serve to fulfill the other goals of ACIATE.

Monograph 2 is the product of the Chairman of the Graduate Studies Committee, Dr. Jerome Moss, Jr. from the University of Minnesota. Researchers who have been interested in creativity in industrial arts immediately face two major problems.

First, what is an acceptable definition of creativity, that elusive characteristic assumed to be developed through industrial arts activity? Second, what instruments now available to the researcher will identify these qualities of creativity in students? Monograph 2 provides the report of a study conducted by Professor Moss in an attempt to provide answers to these two basic questions. Specifically, he has investigated the concurrent validity of the *Minnesota Tests of Creative Thinking* for identifying the unusual and useful behavior of junior high school boys in an industrial arts classroom-laboratory.

Dr. Ethan Svendsen, Indiana State University, Chairman of the Publications Committee has given outstanding leadership to this Committee's work during his term in office. Credit for the success of the Monograph series must be shared with the members of the Committee, Dr. Edward Hinckley of Brigham Young University, Dr. Daniel Householder of Purdue University, Professor Angus MacDonald of San Jose State College and Professor Zeke A. Prust of Arizona State University.

Questions concerning the publication of future monographs should be directed to Dr. Householder, the new Committee Chairman. Since these publications will be printed only when significant materials are identified by the Committee, may I encourage all Council members who possess potential materials to get them to the chairman for early consideration.

HOWARD F. NELSON

President, ACIATE

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This study has been supported by two grants (1963-64 and 1964-65) from the Graduate School, University of Minnesota. The funds enabled the investigator to repay, in a small measure, the contributions of his three co-workers at the University, David Bjorkquist, Richard Bortz, and Diana Rushing.

Special thanks are due to the six teachers used in the study from the Roseville School District, Minnesota, who gave unstintingly of their time and energy; they too must be acknowledged as colleagues: Daniel Beal, Bruce Bernin, Raymond Lundell, Harold Pa Delford, Robert Penning, and Fred Rusch.

Finally, the investigator is grateful to the AIAA Research Committee for the encouragement given in the early stages of the project, to Dr. Howard F. Nelson, Department Chairman, for freely granting the time necessary to pursue the study, and to Dr. E. Paul Torrance for his moral support and counsel.

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Chapter I

INTRODUCTION

STATEMENT OF THE PROBLEM

There are a multitude of definitions for "creativity", yet each implies the eventual production of something new, original, or clever in response to a perceived problem. Thus, the desirability of nurturing creativity in all youth becomes increasingly evident with the growth, in number and complexity, of our social, economic, and technical problems.

Most industrial arts educators recognize that the development of creativity would be an important responsibility of the school should it prove possible. They believe that the tools, materials, and problem-solving opportunities inherent in a laboratory environment might provide an excellent setting in which to enhance creativity. But the research necessary to determine the feasibility of improving creative abilities is dependent upon clarification of the conceptual confusion surrounding the term and the development of satisfactory instruments to measure the desired outcomes. Until these prerequisites are satisfied, "teaching for creativity" will remain a catch phrase for an indeterminate educational objective.

Assuming agreement can be reached on a definition of creativity, suitable criterion measures are difficult to obtain, especially among school age youth. For example, post-facto teacher's ratings typically yield crude measures, they are subject to considerable bias and contamination unless preceded by very careful training, and they require extended observation periods before reliable measures can be acquired. Consequently, the difficulties involved preclude their widespread use. Performance tests are also impractical to utilize in most situations. They consume large portions of time to sample limited amounts of behavior, and they are difficult to score objectively. Therefore, as in the case of intelligence (IQ), researchers in creativity have devoted their major efforts to the development of pencil and paper tests. These have the potential for securing reliable measures with relative ease of administration and scoring, and they may be standardized on large populations. Unfortunately, their present usefulness is severely hampered by a lack of convincing evidence about their concurrent validity. As Thorndike puts it:

> The extension of our appraisal instruments to aspects of divergent and productive thinking is an exciting, promising field for investigation . . . In the meantime, we will be well advised to use with a great deal of tentativeness the term "creativity" as applied to any or all of the tests, or "creative" as applied to children selected on the basis of them (37).

The principal purpose of this study was to estimate the concurrent validity of the pencil and paper *Minnesota Tests of Creative Thinking, Abbreviated Form VII,* for identifying the creative abilities of eighth grade students in industrial arts classes. Concomitant purposes were to investigate the relationships between creative abilities and (a) intelligence, and (b) school achievement of eighth grade industrial arts students.

BACKGROUND OF THE PROBLEM

Most current paper and pencil tests of creativity derive their theoretical base, either directly or with some variation, from the factor analytic studies of Guilford and his associates (13,14,46). Guilford hypothesized that creative behavior is dependent upon five principal primary abilities. "Creativity represents patterns of primary abilities, patterns which can vary with different spheres of creative activity. Each primary ability is a variable along which individuals differ in a continuous manner" (13). The primary abilities are purported to be: (a) sensitivity to problems, (b) fluency of ideas (associational and ideational), (c) flexibility of ideas (adaptive and spontaneous), (d) originality (uncommon ideas, clever responses, remote associations), and (e) redefinition. Further, in his analysis of the structure of the human intellect, Guilford (15) claimed that many of these primary abilities are involved in the intellectual operation of "divergent" thinking. He therefore stated that, in our search for creative talent, "we must look well beyond the boundaries of IQ", which typically requires stable, predictable responses based largely upon the operation of "convergent" thinking. Consequently, makers of creativity tests are wont to indicate the construct validity of their instruments by comparing creativity scores with intelligence test scores; a positive but low correlation is expected in the general population. Also, since learning itself is a reorganization of behavior that should involve the production of novelty as well as remembrance of content, test makers are hopeful that creativity scores will be positively related to indices of school achievement.

The several pencil and paper *Minnesota Tests of Creative Thinking (MTCT)*, developed by E. P. Torrance, purport to measure many of Guilford's primary abilities with complex tasks, using non-specialized content simplified for use at all educational levels. The *MTCT* techniques for administration and scoring are probably more practical and reliable than other available creativity tests, and they yield results which appear to be as consistent with the Guilford theory as the results of other pencil and paper instruments. That is, at high levels of intelligence there is a great diversity of creativity test scores (7,9,12,21,34,40); correlation coefficients tend to be small and often insignificant. As intelligence decreases, however, so does the scatter for creativity (1,24,29). Thus, while high intelligence is not necessarily associated with high creativity, the probability of finding high creativity decreases as intelligence decreases. Creativity test scores do have a small, positive correlation with school achievement in "typical" groups (1) and when intelligence is controlled (48), but in groups having both high intelligence and high creativity scores neither measure is a significant predictor of school achievement (12,34,40).

The evidence bearing on the concurrent validity of the *MTCT* is also as encouraging, and as questionable at present, as that of other tests. The *MTCT* batteries are, under certain situations, able to distinguish between groups with large differences in observed creative abilities (30,40,45), but they have not yet been shown capable of making finer discriminations among students in an industrial environment. On the other hand, of six studies (9,20,26,36) reporting the use of other more specialized test batteries, only two found those batteries capable of distinguishing between groups with large differences in rated creative abilities.

Finally, it should be noted that at least five studies (2,11,23,30,44) have shown it is possible to increase scores on pencil and paper creativity tests, including the *MTCT*, by deliberate educational treatments.

Perhaps one of the reasons why the *MTCT* batteries have not shown greater concurrent validity is the unfortunate use of the total score as a critical measure of creativity. Guilford hypothesized that creative behavior involves patterns of primary abilities, these patterns varying with the nature of the creative activity. Summing abilities is not consistent with the theory. Consequently, a multiple regression approach to the prediction of criterion measures may prove more fruitful.

Personal observation indicates that individuals are usually more creative in certain types of situations than in others. Guilford's model of the intellect takes this phenomenon into account by implying that mental products are the result of an interaction between thought processes, or operations, such as convergent and divergent thinking, and thought materials, such as figural, behavioral, and symbolic content. The measurement of primary abilities with instruments which utilize non-specialized content may not be capable of satisfactorily predicting creative behavior in situations requiring the use of specialized content. The presence of primary abilities conducive to creativity may not be a sufficient condition for creative achievement.

Ausubel (6) expressed the same concern when he argued that creative behavior in a real-life situation requires more than the general (primary) "content-free" creative abilities measured by most pencil and paper creativity tests. The former entails a substantive capacity in a particular field of human endeavor, as well as a capacity for critical self-appraisal, that is not considered by "general" tests. Ausubel concludes that, although a certain minimal degree of the general creative abilities is probably necessary for the actualization of creative potential, above the minimum amount general creative abilities are not co-extensive with substantive creativity.

Thus, while this study estimated the concurrent validity of the *Minnesota Tests of Creative Thinking, Abbreviated Form VII,* in particular, in general, it investigated the capacity of relatively content-free tests of so-called primary creative abilities to measure the actual creative output of students in a particular substantive area.

OBJECTIVES OF THE STUDY

Since an investigation of relationships in the broad, and as yet nebulous, problem area of creativity implies a degree of exploratory activities and the probable application of a host of statistical tests, a list of specific hypotheses has not been presented. Rather, the principal and concomitant purposes have been analyzed into their logical elements and are listed below as important questions to be answered by the study. The questions posed are intended to provide a framework which (a) reflects prior related research and theory, (b) supplies intermediate, sequential goals for the study, (c) suggests appropriate study procedures, and (d) furnishes an organization for presenting conclusions.

1. What definition of "creativity" is (a) compatible with theory and research, (b) capable of operational interpretation in industrial arts classes, and (c) acceptable to selected industrial arts educators?
2. What measurement procedure will yield reliable criterion scores of the relative creative abilities of eighth grade industrial arts students?
3. Do the criterion measures derived by the above procedure have satisfactory construct validity as shown by a comparison with such intermediate indices of creativity as post-facto teacher and peer ratings?
4. What is the extent of the relationship between the criterion measures and each of the measures yielded by the *Minnesota Tests of Creative Thinking, Abbreviated Form VII?*
5. To what extent can combinations of measures yielded by the *MTCT, Abbr. Form VII,* predict criterion measures? What are these combinations?
6. What are the degrees of linear relationship between IQ and (a) criterion measures, (b) measures yielded by the *MTCT, Abbr. Form VII,* and (c) post-facto teacher ratings of creativity?
7. What are the degrees of linear relationship between school achievement, as measured by standardized tests and by teachers' grades, and (a) IQ, and (b) creative abilities, as measured by criterion scores, *MTCT, Abbr. Form VII* scores, and post-facto teacher ratings?

Chapter II

TWO OPERATIONAL DEFINITIONS OF CREATIVITY

MEASURING CREATIVITY IN THE INDUSTRIAL ARTS

The first requirement of the study was to define creativity in a manner that was (a) compatible with theory and research, (b) capable of operational interpretation in industrial arts classes, and (c) acceptable to knowledgeable and interested industrial arts educators. Such a definition must adequately describe the type of behavior industrial arts educators are willing to call creative and to foster; it must provide guidelines for obtaining criterion measures of that behavior such that the measures can be used to validate the results of other more practical techniques which purport to measure the same behavior.

In order to develop such a definition and measurement guidelines it was necessary to recognize at least five of the theoretical and practical issues involved and to take a position on each. The alternatives selected determined the bases upon which the formalized definition rests.

The first issue involved the selection of an approach to be taken to the definition of creativity. As Rhodes (27) formulates it, one can perceive creativity from at least four vantage points: the person of the creator, the press where creation takes place, the process of creation, or the product created. The acceptance of one of these approaches largely determines both the definition of and criteria for creativity. In this study the product approach has been accepted. It was accepted, first, because the school as a social institution must justify its concern with creativity in terms of outcome. Second, while it is the role of educators to learn to manipulate the causative variables of person, process, and press, it is for the ultimate effect of enhancing substantive creativity. It is, therefore, the product which requires initial definition and measurement; the further study of causative and intervening variables must await this prerequisite or lose touch with reality. Finally, the empirical nature of the investigation necessitated selecting the criterion which could be observed and measured most directly and objectively. "When such products are judged to be 'creative', the behavior which produced them can be called creative. The individuals who produced them can also be considered creative" (40,p.40-41). The 1959 Committee report on Criteria of Creativity (33), Ausubel (6), and Strang (32) are among those who agree that the products of creative behavior should be the first object of study.

The second issue was whether creativity should be considered a possession of only the most exceptional individuals, or whether it is the property of all. In the former instance, creative achievement is limited to discovery that is unique in terms of human experience. In the latter case, creativity can be considered to exist on a continuum extending from a negligible to a high degree of achievement. It has been assumed in this study that all persons possess some amount of creativity, just as they possess some degree of most mental abilities. Besides, there would have been little point in conducting a *concurrent* validity study in the industrial arts at the eighth grade level if the criterion measure required only culturally or interculturally unique products.

Although unusualness or originality is fully accepted as a characteristic of creativity, the third issue was to determine the standards for unusualness. The previous paragraph indicated that a creative manifestation need not be limited to the culturally unique. At the other extreme, should unusualness include those products which are unique only to the individual? To take the latter position would make creativity indistinguishable from problem-solving, and even learning, since the definitions of problem-solving and learning require non-habitual behavior from the individual. In addition, measurement would present an almost insurmountable task. Consequently, the study has defined unusualness in terms of peer group behavior. This permitted considering unusualness a variable quality (thus conforming to the decision to treat creativity as a continuous variable) and provided some possibility for measuring it in the school situation.

The fourth issue was whether or not the concept of creativity should include a qualitative component. A great many authors have concluded that to be creative the product must be accepted as tenable, useful or satisfying to some group in time (3,5,10,17,18,28,31). Even Torrance's tests "have required that (original responses) be to some extent adaptive to reality" (42,p.45), and his detailed description of the creative process includes a step for "critically analyzing these solutions for advantages and disadvantages" (40,p.17). The problem seems more practical than theoretical since it revolves around the difficulty of making adequate qualitative judgments. Yet, in the industry which industrial arts is attempting to depict, these judgments are being made constantly, just as they are being made by the U.S. Patent Office. In this study it has been presumed that the school is not justified in encouraging difference just for the sake of difference, but that the development of substantive creativity connotes constructive behavior—the development of unusual ideas inherent in product-solutions which satisfy problems initiated by or posed to individuals. Because the definition formulated is applicable to a specific subject matter field, and because of the "practical" nature of that field, measurement of the qualitative aspects of products was considered feasible. As Guilford notes, for those who deal in practical affairs, "creative work that is to be realistic or accepted must be done under some degree of evaluative restraint" (13,p.453).

The fifth and final issue was whether to consider creativity a general ability or whether to think of it as varying within the individual dependent upon the nature of the content being dealt with. This question has already been considered in Chapter I; it is one of the broad problems being investigated indirectly by the study. Thus, the definition developed for use must provide for several criterion measures, each indicative of performance with a different type of content, so that their interrelationships may be determined.

In light of the above requirements, issues, and decisions the following "Theoretical Model for Identifying the Relative Creative Abilities of Industrial Arts Students" was developed.[1]

> *When a student organizes his past experience in such a manner as to reach an unusual and useful solution to a perceived problem, he has formulated a creative idea. When the idea is expressed in an observable, overt form, he has developed a creative product. A student's creative ability is evidenced by (a) the relative degree of unusualness and usefulness of each of his products, and (b) the total number of his creative products.*

The following material elaborates upon this general definition and provides guidelines for identifying and rating the creative abilities of industrial arts students.

I. *Identifying and Rating a Creative Product*

A. *Product.* An idea or combination of ideas expressed or manifested in any overt, observable form as a solution to a non-factual type problem is a product. Products may take many forms in the industrial arts, such as verbal (oral and written) communications, physical acts, two-dimensional representations, and three-dimensional objects.

B. *Unusualness.* To be creative a product must possess some degree of unusualness. The quality of unusualness may, theoretically, be measured in terms of probability of occurrence; the less the probability of its occurrence, the more unusual the product. The specific probability of occurrence of a particular student's product must be based on the actual or anticipated varieties of products of a peer group having similar experiential background. Thus, to rate the degree of unusualness of a student's product, it is theoretically necessary to (a) be familiar with the frequency of occurrence of varieties of peer products, (b) to select some probability level to represent the norm for "common" products, and (c) to possess means for translating probability deviations from the norm into ratings of unusualness.

C. *Usefulness.* While some degree of unusualness is a necessary requirement for creative products, it is not a sufficient condition. To be creative, an industrial arts student's product must also satisfy the minimal principal requirements of the problem situation; to some degree it must "work" or be potentially "workable." Completely ineffective, irrelevant solutions to teacher-imposed or student-initiated problems are not creative.

Like the quality of unusualness, usefulness is also relative. It is theoretically possible to establish a scale of product usefulness ranging from complete inadequacy to fulfill any of the requirements of the problem situation to products which far exceed the safety, economic, aesthetic, functional and other requisites of an acceptable solution. For example, one point on such a scale might represent the value of the commonly advocated classroom/laboratory practice or the "typical" teacher solution. Care must be taken in evaluating each product to distinguish between the usefulness of the idea inherent in the product and the quality of the manipulative or verbal skill evidenced in expressing the idea as a product; it is the former characteristic that must be rated and not the latter. Identification of the problem, awareness of the actual or potential value of the product-solution, and familiarity with the usefulness of the standard solution are therefore prerequisite to rating the usefulness of a specific student product.

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[1] The "Theoretical Model . . .", and a further interpretation of it, also appears in an article by Moss, J. and Bjorkquist, D. C., "What is Creativity in Industrial Arts," *The Journal of Industrial Arts Education*, 24:24-27 +, Jan.-Feb. 1965.

D. *Combining Unusualness and Usefulness.* When a product possesses some degree of both unusualness and usefulness it is creative. But because these two criterion qualities are considered variables, the degree of creativity among products will also vary. The extent of each product's departure from the typical and its value as a problem solution will, in combination, determine the degree of creativity of each product. Giving the two qualities equal weight, as the unusualness and/or usefulness of a product increases so does its rated creativity; similarly, as the product approaches the conventional and/or uselessness its rated creativity decreases. The following table illustrates one possible model for combining the two essential qualities to arrive at a final creativity rating for each product.

TABLE A

Combined Product Creativity Ratings for Given Ratings of Unusualness and Usefulness

	If the same problem was solved by a group of one hundred typical eighth grade students, would you find—		The solution does not satisfy the principal requirements of the problem	The solution satisfies the principal requirements of the problem	The solution is as good as the commonly advocated or "typical" teacher solution	The solution is better than the commonly advocated or "typical" teacher solution
			0	1	2	3
(Unusualness Rating)	More than 10 similar products	0	0	0	0	0
	Between 6–10 similar products	1	0	1	2	3
	Between 1–5 similar products	2	0	2	4	6
	Less than 1 similar product	3	0	3	6	9

II. *Classifying Creative Products*

While the same thought processes might be universally employed to formulate creative ideas, it is entirely conceivable that the particular type of thought materials being manipulated will differentially influence the efficiency of the processes for various individuals. This could result in students displaying relatively high creative ability with one type of content and relatively low creative ability with another. To provide for this possible phenomenon, creative products should be classified according to a system which reflects fundamental and potentially significant differences among the thought materials used in their production.

For the creative products of industrial arts students, the categories of behavioral, symbolic, and figural content* are proposed. Behavioral content is contained in products dealing primarily with individual and group relationships, such as pupil-teacher and pupil-pupil interactions in persuasive or instructional situations. Symbolic content is displayed in products which represent the aesthetic and other abstract qualities of real, tangible objects or processes, i.e. systems of measurement, dimensioning, coding, and representation, and the artistic aspects of design. Products with figural content contain ideas for the manipulation of real, concrete, inanimate objects and processes; the mechanics of performing an operation, the combination or use of materials for functional purposes, and the sequence or kind of operation used in completing a project are illustrations of this type of content.

It should be emphasized that the system classifies the content of the idea manifest in the unusual aspect of the product, and not the particular form of the product itself. For example, oral suggestions are products; these may contain unusual ideas for securing better cooperation among students (behavioral), improving the aesthetic qualities of a design (symbolic), or for arranging machinery for a mass production project (figural). Similarly, a sketch might utilize conventional symbols in an unusual manner (symbolic), or depict a new device for mitering wood (figural).

In addition to the proposed categories of creativity based on type of content (behavioral, symbolic, figural), the possibility exists that the more specific materials (wood, metal, etc.) dealt with in various industrial arts classes might also influence the extent of each student's creative abilities. Until there is an opportunity to test such an hypothesis, care must be taken in assuming that ratings of creative abilities in one industrial arts course are equivalent to what they might be in other industrial arts courses.

Consequently, during initial attempts to rate creativity, industrial arts courses differing in content should be treated discretely, and within each course behavioral, symbolic, and figural creative abilities should be rated separately.

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*J. P. Guilford, "Three Faces of Intellect," *American Psychologist*, 14:469-479, 1959.

III. *Assessing the Relative Creative Abilities of Students*

Within a given industrial arts course, each product of every student should be evaluated in terms of its unusualness. If a product is judged to be unusual to some degree (above a zero rating), its usefulness must then be estimated, and the two ratings entered on the student's record in the proper content category (behavioral, symbolic, or figural).

Under similar environmental conditions, the higher the ratings for each creative product and the greater the number of creative products within each content category, the more creative the student is with content of that nature. To assess the relative creative abilities of students, it is possible to compare their creative production, over a given length of time, in each of the content categories. A relative measure of total "creativity" may be obtained by comparing students' cumulative creative productivity in all content categories.

In utilizing the definition to secure criterion measures of relative creative abilities, eight different sets of scores may be obtained: (a) behavioral unusualness, (b) behavioral creativity, (c) symbolic unusualness, (d) symbolic creativity, (e) figural unusualness, (f) figural creativity, (g) total unusualness, and (h) total creativity. The unusualness scores are based on the probability of occurrence of a product; the creativity scores combine unusualness with a measure of usefulness of the product. Total scores are the sums of the appropriate content category scores.

The "Theoretical Model . . . " was submitted to two measurement specialists and six educational psychologists to determine its theoretical and practical consistency. Both measurement specialists[2] felt that the definition provided a feasible basis for securing criterion measures. Four of the six educational psychologists responded to the request for critical evaluation:

1. Professor J. W. Getzels believed the model to be "... sensible and useful", and, in fact, generalizable to other areas as well. He was pleased that provision had been made to investigate differences in creative abilities as they relate to differences in content.

2. Professor P. W. Jackson thought that both unusualness and usefulness were clearly important criteria to apply in the assessment of creative products, but that, lacking more detailed information about the measurement techniques to be used, he was unable to evaluate the application of these criteria in judging specific products.

3. Professor J. P. Guilford concurred in the choice of unusualness as a criterion. He would not have included usefulness if the aim of the study was to solve a basic science problem. Since the study is concerned with a technological problem, and because the combination of unusualness and usefulness does have a basis in

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[2] Professors Cyril Hoyt and Jack Merwin, University of Minnesota.

tradition, Guilford conceded that there is a "logical defense" for including usefulness as an evaluative variable.

4. Professor E. P. Torrance agreed that the "Theoretical Model . . ." was most appropriate for the purposes of the investigation.

Thus, it would appear, on the basis of the opinions of a small but knowledgeable panel of "experts", that the "Theoretical Model . . ." may be considered compatible with existing theory and practice.

In order to determine whether the proposed theoretical approach to obtaining criterion measures of relative creativity in the industrial arts was acceptable to members of the profession, copies of the "Theoretical Model . . ." were sent to a purposive sample of fifty-seven industrial arts teacher educators; these persons were selected on the basis of their prior interest in and information about creativity. Each recipient was asked to examine the "Theoretical Model . . ." carefully and critically and to submit his reactions by letter. No opinionnaire form was included in the mailing because unstructured evaluations were deemed to be of greatest value; respondents were, however, requested to begin their replies with one of three basic statements: "First, you might accept the definition and guidelines as they now appear. Second, you might agree with them in the main, but wish to provide suggestions for certain additions and/or revisions designed to improve the material. Finally, you might disagree with the major premises, and require that certain revisions and/or additions be made before the definition and guidelines can be accepted."

A total of forty-three of the fifty-seven industrial arts teacher educators responded to the request for a critical appraisal.[3] The unstructured replies varied from three-quarters of a page to several pages in length; each revealed that considerable time and careful thought had been given to the evaluation. To reduce the possibility of misinterpreting respondent comments, each reply was analyzed separately by two judges and the analyses were compared to detect discrepancies.

Sixty-seven percent of the replies accepted the "Theoretical Model . . ." as it appears. Thirty-three percent agreed with the definitions and guidelines in the main, but provided suggestions for additions and/or revisions designed to improve the material. No one disagreed with the major premises or required that certain revisions or additions be made before the "Theoretical Model . . ." could be accepted.

Many of the comments received were essentially requests for clarification rather than change. Some comments were relevant to the measurement technique that would be utilized, and its reliability. There were the usual semantic problems. After careful consideration it was decided not to alter the "Theoretical Model . . ."; the preponderance of complete agreement and the opportunity to clarify the definition and guidelines through its application in this study provided the justification for the decision.

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[3] Responses were received from the following persons and are gratefully acknowledged: D. H. Anderson; W. C. Anderson; R. P. Balin; C. R. Bartel; R. Bohn; K. W. Brown; E. Ciancone; K. R. Clay; R. N. Evans; J. L. Feirer; R. D. Gallington; I. Hostetler; R. C. Hutchcroft; F. D. Kagy; M. R. Karnes; W. A. Kavanaugh; F. C. Krubeck; A. K. Lahti; A. A. Lease; J. R. Lindbeck; D. Maley; W. R. Miller; W. H. Middleton; J. Mitchell; H. F. Nelson; D. W. Olson; C. B. Porter; W. Robinson; J. D. Rowlett; W. J. Schill; M. Schmitt; J. M. Shemick; G. H. Silvius; W. S. Sommers; A. R. Suess; M. N. Sulentic; E. Svendsen; R. S. Swanson; R. A. Tinkham; E. M. Weber; W. R. Williams; L. S. Wright; L. W. Yoho.

Having determined the reasonable acceptability of the proposed definition of creative abilities and guidelines for their measurement, the next steps in the study required selecting a specific procedure for securing criterion measures of relative creative abilities consistent with the definition, developing techniques and forms to facilitate data collection, and trying out the data collection procedure.

Two alternative procedures for securing criterion measures were apparent. The first involved the development and administration of specially constructed performance tests appropriate for the industrial arts. The second involved securing teacher ratings of student behavior (products) *as it occurred* in the typical industrial arts classroom/laboratory over a period of time. The former procedure is less time-consuming, is likely to result in more objective rating, and will assuredly yield scores for all students in all three content categories. The latter procedure, however, will provide a larger sample of student behavior, measure actual creative output in a substantive area, and will make it possible for students to display, and thus have incorporated in their ratings, self-initiated creative behavior; it should, therefore, be a better predictor of future behavior in similar real-life situations.

In light of the potential advantages of the "teacher rating in typical situations" approach, it was chosen for use in the study.[4] At least one important assumption is being made in the application of this approach; the definition assumes that creative products are developed by creative persons who possess creative abilities, and the measurement procedure then presumes that persons with creative ideas will manifest those ideas in the school situation, and will not deliberately restrain them.

A trial of the data collection procedure was conducted during April-May, 1964. Five instructors in the Department of Industrial Education, University of Minnesota, volunteered to act as teacher-raters in their respective laboratory classes for a five week period in order to check the feasibility of the data collection procedure and to determine the most effective teacher-rater training and data recording techniques. In the training session, the definition and guidelines were explained by the investigator, several sample products served to illustrate the rating scales and procedures, and products suggested by the teacher-raters on the basis of their past experience were used to provide practice in rating product unusualness and usefulness and in classifying the content of the unusual idea inherent in each product. These five teacher-raters met with the investigator at the end of each of the five weeks to discuss problems evident in the procedure, to rate the products observed by each other during the week, and to suggest changes in recording techniques. As a result of the five week trial period it was decided that the overall procedure was practical, provided the students could be observed for at least one semester in courses which were "problem-centered" as opposed to "fact-centered", that acceptable agreement among teacher ratings of products could be obtained, and that, when properly alerted and motivated, teachers were capable of efficient observation of their students' classroom/laboratory behavior. Valuable ideas were gleaned for the training session, creative products to be used as training examples were gathered, and revisions were suggested in the data recording forms and techniques.

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[4] The specially constructed performance test approach is now being applied by L. G. Duenk, using the same sample of students at the same time as this study, in a Ph.D. dissertation tentatively titled, "A Study of the Concurrent Validity of the 'Minnesota Tests of Creative Thinking, Abbr. Form 7,' for Eighth Grade Industrial Arts Students."

MINNESOTA TESTS OF CREATIVE THINKING, ABBREVIATED FORM VII

> "I have tried to describe creative thinking as taking place in the process of sensing difficulties, problems, gaps in information, missing elements; making guesses or formulating hypotheses about these deficiencies; testing these guesses and possibly revising and retesting them; and finally in communicating the results."—Torrance (42)

Since 1958 Torrance and his associates have been developing pencil and paper tests, each consisting of one rather complex task, which can be assembled into various batteries for the purpose of measuring creative abilities. "One strategy that we have used constantly is to generate ideas for test tasks and for scoring them from descriptions of the creative process, the behavior of creative men and women in achieving their breakthroughs, and the like" (42,p.45).

Typically, each test is scored in several ways, each measure being indicative of some creative ability which Torrance feels is involved in the creative process and in producing creative ideas of any kind. In the development of the tests an attempt has been made to utilize complex tasks (a) whose appropriateness is as universal as possible, (b) which require both verbal and non-verbal response symbols, and (c) which can be administered to individuals or to groups using either real objects for manipulation, films or slides, tape recordings, or ordinary printed forms.

The *Minnesota Tests of Creative Thinking, Abbreviated Form VII,* was originally assembled from available test tasks for use in evaluating the effects of experimental programs on creative growth in which testing time was limited. *Form VII* consists of four tests, (two verbal and two non-verbal) each requiring ten minutes completion time; the battery can be administered conveniently in a fifty-minute class period. The battery is intended to be used with groups at the fourth grade level or above. No additional materials, besides the test battery booklet and a pencil, are needed, and the instructions contained in the test battery booklet should be supplemented only by a brief oral introduction. The name, description, rationale and scores yielded by each of the four tests in the battery are noted in Table 1.[5]

While Guilford preferred each of his tests to be factorially pure, and Torrance has insisted upon the development of complex tasks, the

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[5] At present, permission to use any of the *Minnesota Tests of Creative Thinking* must be secured from Dr. E. P. Torrance, College of Education, University of Minnesota.

TABLE 1

Minnesota Tests of Creative Thinking, Abbreviated Form VII

	Test Name	Description	Rationale	Some Scores Yielded
1.	Figure Completion (Non-verbal)	Ten incomplete figures are presented to which lines should be added in order to sketch interesting objects or pictures.	Sets up tension for completion; individual must delay gratification to produce original and elaborate figures.	Fluency, flexibility, originality, elaboration, total.
2.	Circles (Non-verbal)	Thirty-six circles are presented; objects or pictures are to be drawn using one or more circles as the main part of the drawing.	Designed as a non-verbal test of four types of divergent thinking, but due to limited time each individual must choose the relative emphasis to be placed on fluency, flexibility, originality or elaboration of responses.	Fluency, flexibility, originality, elaboration, total.
3.	Product Improvement (Verbal)	Ideas are to be listed for changing a stuffed toy dog so that it will be more fun for children to play with.	Permits the subject to utilize ideas that he would not dare express in a more serious situation; "regression in the service of the ego".	Fluency, flexibility, originality, elaboration, total, and inventive level.
4.	Unusual Uses of Tin Cans (Verbal)	Interesting, unusual ideas for using empty tin cans are to be listed.	Tests ability of individual to free his mind of well established sets.	Fluency, flexibility, originality, elaboration, total.

type of scores yielded by *Abbreviated Form VII* reveals the basic similarity between the two approaches in terms of the abilities each attempts to identify. Every test in *Abbreviated Form VII* is scored for fluency, flexibility, originality, and elaboration; each of these has a counterpart among the abilities identified by Guilford. Fluency is interpreted as an index of ability to produce a large number of ideas; it is scored by counting the total number of different relevant responses to a given task. Flexibility is the ability to produce a variety of ideas or approaches; it is scored by counting the number of different categories into which the total number of responses to a task may be classified. Originality is the ability to produce novel, statistically infrequent ideas which are adaptive to reality; it is scored by crediting each response with a variable score dependent upon the relative frequency with which the response has been made by a comparable norm group. Elaboration is the ability of integration and exposition of detail; it is scored by giving credit to the number of pertinent ideas which have been added to a primary response. Inventive level, a score derived only from the "Product Improvement" test, has no single counterpart among the Guilford factors; it is an attempt to adapt practical criteria for patentable products to a particular task, and therefore represents a combination of intellectual energy, originality, adequacy of planning, sensitivity to problems, and evaluative and usefulness factors.

After each test is scored for its four factors, and "Product Improvement" is scored in addition for inventive level, eight different measures are ordinarily computed for the test battery as a whole: (a) fluency is the sum of the fluency scores of each of the four tests; (b) flexibility is the sum of the flexibility scores of each of the four tests; (c) originality is the sum of the originality scores of each of the four tests; (d) elaboration is the sum of the elaboration scores of each of the four tests;[6] (e) inventive level is the inventive level score on the "Product Improvement" test; (f) non-verbal is the sum of the scores derived from the "Figure Completion" and "Circles" tests; (g) verbal is the sum of the scores from the "Unusual Uses of Tin Cans" and "Product Improvement" tests (excluding the inventive level score); (h) grand total is the sum of the non-verbal and verbal scores.[7] About twenty minutes are needed to score *Abbreviated Form VII* completely.

Previous experience with the battery has shown that inter-scorer agreement on all factors in all tests may be expected to be around .90 or higher (42). The test-retest reliability of the total battery score has averaged approximately .80, while the stability of part scores is in the vicinity of .65-.70 (42,43). Both types of reliability seem to be sufficiently high to warrant using the battery in experimental situations.

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[6] Separate verbal and non-verbal fluency, flexibility, originality, and elaboration scores may be computed if desired. Since the criterion measures in this study reflect a combination of verbal and non-verbal products, and because the separate test scores are likely to be less reliable, no such distinction was made.

[7] It is often desirable to add standard rather than raw scores in order to give equal weight to all factors. To check this, the fluency, flexibility, originality, and elaboration scores of twenty-four students in the study were converted to standard scores. summed, and the resultant totals correlated with the sums of the raw scores; a coefficient of .98 was obtained. Since the variances of the four raw score distributions were significantly different (.05), there appeared to be little reason not to use raw score totals throughout the study.

Chapter III

DATA COLLECTION

SELECTING TEACHER-RATERS AND THE SAMPLE

The procedure chosen to secure criterion measures of relative creative abilities, namely, using teachers to observe, rate, and classify student products as they were manifested in typical industrial arts environments, required the careful selection of teacher-raters. Therefore, the first step in the data collection process was to nominate teachers who were considered suitable to participate in the study, and then to attempt to secure their cooperation. The sample of students was subsequently defined in terms of the classes taught by the cooperating teacher-raters.

A panel of four staff members of the Department of Industrial Education, University of Minnesota, was formed in order to secure nominations for teacher-raters from among the available junior high school industrial arts personnel in the Minneapolis-St. Paul metropolitan area.[8] Each panelist was asked, individually, to name (a) four school systems in the area which provided large, complete, and "good" junior high school industrial arts programs, (b) the teachers within each of those systems who were sympathetic to the development of creative abilities, provided the most opportunities in their classes for the expression of creativity, and had more than two years of junior high school industrial arts teaching experience, and (c) teachers outside of the four school systems who met the criteria in (b), above.

Independent School District No. 623 (Roseville), Minnesota, was named by all four panelists. Within this system, four teachers were nominated by all four panelists and two others were designated by three panelists. No other school system suggested had as much panel agreement on individual teachers. Even when the total target area was considered, no other six teachers accumulated more nominations.

Permission to conduct the study, provided individual teachers agreed to cooperate, was granted readily by Independent School District No. 623. As a confirmation of the panelists' judgment, all six instructors nominated immediately expressed their willingness to assist in the conduct of the study.

After discussion with the six teacher-raters (four of whom were in one school, and two in another), it was unanimously agreed to use eighth grade rather than seventh grade students as subjects; most of the time in the seventh grade classes was ordinarily devoted to presenting facts and developing specific manipulative skills, while in the eighth grade much more time was typically spent in various types of problem-centered activities. Industrial arts was required of all boys in both the seventh and eighth grades, but not in the ninth grade.

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[8] The panelists had from three to fourteen years of experience as teacher educators and as supervisors of student teachers in the Minneapolis-St. Paul area; thus, each was familiar with most, if not all, of the potential candidates. Also, all the panelists were familiar with and subscribed to the definition of creativity used in the study.

Six, eighth grade industrial arts class sections participated in the study throughout two consecutive quarters (a total of eighteen weeks). These sections were taught by the teacher-raters selected, and constitute the original sample for the study. Students were assigned to class sections by a computer; there was no attempt to make sections homogeneous with respect to any relevant variable.

With the cooperation of the Principals in both schools, the original sample was grouped into three pairs of sections and scheduled so that each pair was taught by one of three teacher-raters the first quarter (nine weeks) and by one of the other three teacher-raters the second quarter (nine weeks). Thus, it was possible to consider the original sample to be composed of three groups; all the students in one group, or pair of sections, received the same course content, in the same sequence, from the same two teacher-raters over the eighteen week observation period. Because of the differences among the groups in content experienced and/or teacher-raters used, it was not possible to pool the criterion measures of the three groups at any time during the study. Table 2 shows the teacher-raters used and the courses taught to each of the three groups of students during the first and second quarters.

TABLE 2

Teacher-Raters and Course Content Used With Each of the Three Groups in the Original Sample

Group (Two Sections Each)	First Quarter (Nine Weeks)	Second Quarter (Nine Weeks)
I	Teacher A Drawing-Graphic Arts	Teacher B Metals
II	Teacher C Woods	Teacher D Electricity
III	Teacher E Woods	Teacher F Electricity

At the beginning of the study, the six teacher-raters had taught an average of 7.7 years; their junior high school teaching experience ranged from 3-8 years, with a mean of 5.3 years. Five of the six teacher-raters had previously taught the same course content they taught during the study to 32-64 class sections of eighth graders. The sixth teacher-rater (A) had taught the same content 17 times previously to seventh and ninth graders; this was the first semester, however, that eighth graders had been scheduled in that course.

In their judgment of student products, teacher-raters could not be expected to distinguish between creativity and atypical prior experience with the content as the cause for producing unusual and useful products.

It was therefore necessary to make the students within each group as homogeneous as possible with respect to their direct prior experience with the content of the two courses they were to take. This was done in two ways. First, since most of the students had already taken seventh grade courses in drawing and woods, those who hadn't, and who were going to be rated while engaged in one of those two subjects, were eliminated from the original sample.[9] Second, each student in the original sample completed a "Student Information" form which revealed the extent of his out-of-school experience with the industrial arts subjects he was to take during the study. About 12% of the students indicated that they spent an average of four or more hours each week in pertinent activities. This was considered exceptional. Two other items on the "Student Information" form were used to check the consistency and reasonableness of the students' time estimates and resulted in reducing the 12% to 8% of the students. The teacher-raters of this 8% were then consulted to determine whether they had noticed evidences of such exceptional experience; where they hadn't, each student was interviewed to confirm his written responses. Confirmation by the teacher-rater or by the student led to elimination of the student from the original sample.

In addition to the attempt to reduce contamination of the criterion measures of relative creative abilities by eliminating students with exceptional direct prior experience with the course content, it was necessary to eliminate from the original sample students with atypical absentee records. Obviously, excessive absenteeism seriously reduced the relative opportunity of the individual to manifest creative abilities. The distribution of days absent during the semester data collection period showed a reasonably steady decline in numbers of students absent from zero to seven days, with only one or no students absent from eight to a maximum of thirty-one days; the mean was 3.26 days and the standard deviation 4.29 days. Consequently, it was decided that plus or minus one standard deviation would represent the range of tolerable absences. This meant that any student absent eight or more days was dropped from the original sample.[10]

Table 3 summarizes the foregoing steps by presenting the numbers in the original sample, the reductions due to exceptional in-school experience, out-of-school experience, and excessive absences, and the net sample.

At the conclusion of the data collection period, the teacher-raters reported on the nature of the courses they had offered to the sample. As might be expected, in addition to differences in subject matter, the methodology and approaches utilized by teacher-raters were quite diverse. On the average, however, about 40% of the class time of the

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[9] This proved to be an appropriate step since a subsequent analysis of the criterion measures showed that those with no prior seventh grade experience produced substantially fewer creative products than those with prior experience in the subject.

[10] After criterion measures were collected, it was found that 38% of those eliminated due to excessive absences had produced no creative products, while only 24% of the remaining students had produced no creative products.

TABLE 3

Original Sample and Eliminations

Group	Original Sample	Exceptional In-School Experience	Exceptional Out-of-School Experience	Excessive Absences	Net Sample
I	39	5	0	2	32
II	48	16	2	6	24
III	46	6	0	1	39
Total	133	27	2	9	95

three groups was devoted to learning informational (related) content provided by lecture, discussion, and written materials. The remaining 60% of class time was spent by students watching demonstrations, planning projects, and carrying out projects. Four of the teacher-raters had students work individually on projects, while one used small group projects and another employed mass production projects. In all groups, the students did most of the project planning, with some assistance from the teacher-raters.

TRAINING TEACHER-RATERS AND COLLECTING CRITERION MEASURES

A seven-hour training session was held for all six teacher-raters two days before the start of the quarter in which the first three of the teacher-raters were scheduled to observe and rate the creative products of members of the sample.

The training session was organized into thirteen units: (a) introducing the personnel involved in the study, (b) overviewing the objectives of the study, (c) stating the purposes of the training session, (d) providing definitions of and scoring standards for "product", "unusualness", and "usefulness", and then having the group rate and discuss ten sample products, (e) providing definitions of the three content categories, and then having the group classify and discuss ten sample products, (f) eliciting examples of creative products from the teacher-raters based upon their past experience, and rating and classifying each product, (g) administering a test consisting of twenty additional creative products to be rated and classified, (h) reviewing the test results to identify and clarify misunderstandings about definitions and scoring standards, (i) presenting the forms and recording procedures to be employed by the teacher-raters, (j) summarizing rating, classifying, and recording procedures, (k) suggesting ideas for providing creative problem-solving opportunities in the classroom/laboratory, (l) advising teacher-raters of future activities in the study, and

(m) distributing copies of the training session notes and sample executed forms for their future reference.[11]

The twenty-product test administered during the training session contained products from the subject areas of woods (10), metals (6), graphic arts (2), drawing (1), and crafts (1); figural ideas (12), symbolic ideas (5), and behavioral ideas (3) were included among the twenty products, which also represented the full range (0-3) of possible unusualness and usefulness ratings. The test results were analysed to determine the reliability of the teachers' ratings, and thus provided some measure of the success of the training session. Ninety-three percent agreement was found among the teacher-raters on their classification of content.[12] A conservative estimate of the reliability of each teacher-rater's unusualness ratings was found to be .71, while a comparable estimate of reliability for usefulness ratings was .69.[13] These reliabilities indicated that teacher-raters possessed a sufficient degree of common understanding of the definitions and scoring standards to warrant proceeding with the data collection.

Because three of the teacher-raters did not begin to observe and rate the products of the students in the sample until nine weeks after the training session, re-training was provided for them in a one-hour session held just before the beginning of the second quarter. A condensed version of the initial training procedure was utilized for this purpose.

Briefly, the task of each teacher-rater was to observe closely the behavior of all students in the sample. When a student performed in an unusual manner (according to minimum standards for unusualness), the *idea* inherent in the product (behavior) was to be rated for unusualness, then usefulness, and then classified according to the appropriate content category. These ratings were to be recorded immediately on a "Pocket Memo" pad, and, before the end of the day, recorded permanently on that student's tabulation sheet in a "Product Rating" folder. In addition, teacher-raters completed an "Anecdotal Record" describing in detail every fifth product rated in each of the three content categories for the pair of sections they were teaching.

In order to help insure that teacher-raters performed their duties properly, maintained acceptable rating standards, and retained a maximum of motivation for the task, each teacher-rater was visited at least once a week by the investigator or his assistant throughout the data collection period. During these visits, special attention was given to checking and/or discussing the following: (a) questions posed by the teacher-rater, (b) the manner in which the forms were being completed, (c) ideas for increasing the opportunities for student creative behavior,

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[11] Because of space limitations, the investigator's notes, recording forms, ten sample products, and the twenty-product test used in the training session have not been reproduced.

[12] $\% \text{ agreement} = \dfrac{\text{Total number of ratings} - \text{Number of deviant ratings}}{\text{Total number of ratings}}$

[13] $\dfrac{\text{MS items} - \text{MS residual}}{\text{MS items} + (\text{K-I})\ \text{MS residual}}$ Winer, B. J., *Statistical Principles in Experimental Design,* New York, N. Y., McGraw-Hill, 1962, pp. 124-32.

(d) reasons for awarding specific ratings to a random sample of previously observed products, (e) the necessity for observing all students and for providing all with equal opportunity to behave creatively.

The week following the conclusion of the semester observation period, the six teacher-raters met to rate and classify each of the student products that had been described in all of the "Anecdotal Records" completed by all of the teacher-raters during the semester. The forty products thus assembled included figural ideas (33), symbolic ideas (3), behavioral ideas (4). The distribution of unusualness ratings was one's (10), two's (16), and three's (14); usefulness ratings consisted of zeros (2), one's (5), two's (24), and three's (9). An estimate of the reliability of each teacher's ratings of the actual student products described in the "Anecdotal Records" was obtained by comparing his ratings on unusualness, usefulness, and content classification, and creativity[14] with the average ratings of the other five teacher-raters on the forty products. Table 4 presents the resultant coefficients.

TABLE 4

Estimated Reliability* of Each Teacher's Ratings of Student Products Described in the Anecdotal Records
(N = 40)

Teacher-Rater	Unusualness	Usefulness	Content Classification	Creativity
A	.82	.68	1.00	.68
B	.78	.73	1.00	.83
C	.73	.70	1.00	.73
D	.76	.75	1.00	.71
E	.72	.74	1.00	.75
F	.76	.58	1.00	.59

$$^{*}\frac{\text{MS items} - \text{MS residual}}{\text{MS items} + (\text{K-I})\text{MS residual}}$$

Since a portion of the forty student products described in the "Anecdotal Records" represented products that had previously been rated by each teacher during the observation period, it was possible to estimate the stability of each teacher's ratings by comparing the ratings given by him during the observation period with those given by him in the post-observation rating session. The small number of products rerated by each teacher should be considered in evaluating the obtained coefficients, shown in Table 5.

Because the forty student products described in the "Anecdotal Records" represent a restricted random sample of one-fifth of the total student products and one-fifth of the products each teacher actually

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[14] The creativity score of each product was determined by multiplying the unusualness by the usefulness rating.

TABLE 5

Estimated Stability* of Teachers' Ratings of Student Products

Teacher-Rater	Interval Between Ratings (Weeks)	N	Unusualness	Usefulness	Content Classification
A	10–19	10	.71	.68	1.00
B	1–10	7	1.00	1.00	1.00
C	10–19	8	.68	.84	1.00
D	1–10	6	.71	.79	1.00
E	10–19	4	1.00	.58	1.00
F	1–10	5	1.00	1.00	1.00

* Pearson product-moment correlations for unusualness and usefulness ratings.

rated during the course of the semester observation period, the coefficients shown in Tables 4 and 5 provide a reasonable basis for estimating the reliability of teachers' ratings of students' products during the study. The coefficients appear to be sufficiently high to justify the acceptance of the teachers' ratings and to warrant their use as criterion measures in the study.

From the individual product ratings, eight criterion measures were obtained for each student :(a) figural unusualness was the sum of the unusualness ratings given to his recorded figural products, (b) symbolic unusualness was the sum of the unusualness ratings given to his recorded symbolic products, (c) behavioral unusualness was the sum of the unusualness ratings given to his recorded behavioral products, (d) figural creativity was the sum of the unusualness times usefulness ratings of each of his recorded figural products, (e) symbolic creativity was the sum of the unusualness times usefulness ratings of each of his recorded symbolic products, (f) behavioral creativity was the sum of the unusualness times usefulness ratings of each of his recorded behavioral products, (g) total unusualness was the sum of his figural, symbolic, and behavioral unusualness, and (h) total creativity was the sum of his figural, symbolic, and behavioral creativity.

As stated in the proposed definition of creative abilities, unusualness is *not* considered a sufficient condition of creativity. Unusualness measures, therefore, do not represent true criterion measures. However, since it was possible that the results of the *MTCT, Abbr. Form VII* might be more highly related to unusualness alone than to a combination of unusualness and usefulness, the unusualness measures in the three content categories were secured as separate measures.

ADMINISTERING *MINNESOTA TESTS OF CREATIVE THINKING, ABBREVIATED FORM VII* AND OTHER CREATIVITY RATING SCALES

Approximately halfway through the semester data collection period, the *MTCT, Abbr. Form VII* was administered to the six class sections comprising the original sample. The battery was given to each class section during a regular fifty-minute class period; all four sections in one school were tested in one day, while the two sections in the second school were tested on the following day.

All the test batteries were scored by one person. A random selection of twenty-five test batteries was taken from the sample and scored independently by a second person in order to estimate scorer reliability. Table 6 shows the resultant coefficients and indicates the expected high reliability of the scoring procedure.

TABLE 6

Scorer Reliability* on *MTCT, Abbr. Form VII*

(N = 25)

Score	Reliability
Fluency	.95
Flexibility	.85
Originality	.94
Elaboration	.97
Inventive Level	.99
Non-verbal Total	.92
Verbal Total	.98
Grand Total	.96

* Pearson product-moment correlations.

Post-facto supervisor ratings and peer ratings of creativity have been used in other studies as criterion measures; their inadequacies in this role are well known. This study, however, utilized both those types of ratings to estimate the construct validity of the criterion measures; they provide some clue as to the realism, reasonableness, and acceptability of the criterion measures.

Post-facto teacher ratings were gathered from individual teacher-raters, without prior notice, at the close of their respective quarter observation periods. Under the direct supervision of the investigator, each teacher-rater was asked to name the most creative student (the one with the most unusual and clever ideas), the least creative student, the student halfway between them, etc., until nine students, representing a nine point scale from high to low creativity, had been identified from the combined class rolls of the two sections he had observed. Every remaining student in both sections was then rated as having an amount of creativity most like one of the nine students originally identified. The result was to secure ratings of one to nine for each student that could be treated as interval measures. The ratings of the two teachers who had observed the same two sections of students were averaged to obtain the measures used in the study. Table 7 presents estimates of the reliability of the average ratings of each pair of teacher-raters.

TABLE 7

Estimated Reliability* of Average Post-Facto Teacher Ratings

Teachers	Reliability
A, B	.72
C, D	.70
E, F	.36

$$* \frac{\text{MS items—MS residual}}{\text{MS items}}$$

It is interesting to note that the reliabilities of the *average* of two teachers' post-facto ratings is generally no greater than the reliabilities of a single teacher's ratings of student products, despite the fact that post-facto ratings were undoubtedly greatly influenced by prior teacher training in defining creative abilities and by unusually careful observation of students during a full quarter's work. The post-facto reliabilities tend to bear out the pessimism with which these ratings are generally viewed, and, in this study, raise serious questions about the cause of the unsatisfactory agreement between Teachers E and F.

The investigator and one assistant collected peer ratings of relative creative abilities at the end of the semester observation period by administering a rating instrument to each of the six class sections in the original sample. It took approximately twenty-five minutes of a regular class period for each student to rate every other student in the class section. The instrument utilized was very similar to that used to obtain post-facto teacher ratings, except that a five instead of a nine point scale was employed. Unlike post-facto teacher ratings, which pertained to the relative creative abilities of individuals within a pair of sections (group), peer ratings were indices of relative creative abilities within each class section. All the ratings given to each student by his classmates were averaged to obtain the rating used in the study. Table 8 shows the satisfactory reliabilities of the mean peer ratings for class sections.

OBTAINING SOCIO-ECONOMIC, APTITUDE, AND ACHIEVEMENT MEASURES

Measures indicative of the socio-economic status, aptitude, and achievement of the sample were gathered for descriptive purposes and/or for investigating their relationships with measures of relative creative abilities.

Information about the occupational distribution of the parents of the sample was collected for descriptive purposes by means of the "Student Information" form previously noted in the first section of this

TABLE 8

Reliability* of Mean Peer Ratings Per Class Section

Group I		Group II		Group III	
Section 1	**Section 2**	**Section 1**	**Section 2**	**Section 1**	**Section 2**
.93	.96	.86	.92	.89	.94

$$*\frac{\text{MS items} - \text{MS residual}}{\text{MS items}}$$

chapter. The form was distributed by the teacher-raters during the first part of the first quarter. Teacher-raters explained the questions to the students, and collected the completed forms the following day. Comparisons (chi-square) of percents of parental employment by major occupational category between the distributions of pairs of the three groups comprising the parents of the sample showed significant (.05) differences between all three groups within the sample. The occupational distribution of the parents of the total sample was also significantly different (.05) from both the civilian employment distribution in Minnesota and in the U. S.

Student verbal and non-verbal aptitude measures were available as raw scores in each student's "Cumulative Record" folder. These scores resulted from an administration of the *Lorge-Thorndike Intelligence Tests, Level 4, Form A* during the early part of the seventh grade; scores were thus about one year old. Raw scores were converted to IQ scores by the investigator, using student's chronological age obtained from "Cumulative Record" folders and the conversion tables in the Lorge-Thorndike *Examiner's Manual.*[15] This particular intelligence test attempts to measure the ability to work with ideas and the relationships among ideas. Reasoning, as expressed by both verbal and non-verbal symbols, is one of the primary areas tested.

Two types of data were gathered to obtain evidence of student achievement. First, five standardized achievement tests were administered to the sample about halfway through the semester observation period as a part of the regular testing program of both schools. Current raw scores were thus obtained for each of the following tests: (a) *Triggs Diagnostic Reading, Form A, Survey Section* (total score), (b) *STEP Social Studies, Form 3A,* (c) *STEP Writing, Form 3A,* (d) *Snader General Mathematics, Form AM,* and (e) *Read General Science, Form AM.* Second, grades awarded by teachers during the seventh grade were recorded in students' "Cumulative Record" folders. These grades, plus the two grades earned by students in industrial arts during the observation period of the study, yielded eight measures of teacher's grades: (a) combined average of seventh and eighth grade industrial arts (5 quarters), (b) average seventh grade English (4 quarters), (c) average seventh grade social studies (4 quarters), (d) average seventh grade mathematics (4 quarters), (e) average seventh grade industrial arts (3 quarters), (f) average seventh grade science (2 quarters), (g) seventh grade art (1 quarter), and (h) overall seventh grade average (giving equal weight to each quarterly grade in every subject previously noted).

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[15] Lorge, I. and Thorndike, R. L., *Examiner's Manual: The Lorge-Thorndike Intelligence Tests, Level 4, Grades 7, 8, and 9,* Boston, Mass., Houghton Mifflin Company, 1957.

Chapter IV

FINDINGS

CRITERION MEASURES

Two objectives of the study were to determine the reliability and the construct validity of the criterion scores yielded by the measurement procedure. It has already been shown that all the teachers utilized were able to rate and classify *identified* student products with reasonable reliability. Further, as a direct application of the "Theoretical Model for Identifying the Relative Creative Abilities of Industrial Arts Students", the measurement procedure may be considered consistent with the proposed definition of creativity. But before the two objectives can be satisfied, the results of all the product ratings obtained during the study must be examined to determine (a) whether the measurement procedure resulted in identifying a sufficient number of creative products to warrant the assumption of reliable measures of individual student creativity in each content category, (b) whether the arithmetic technique of multiplying, rather than adding, unusualness and usefulness ratings to obtain creativity scores had some empirical justification, (c) the degree to which the total creativity scores were related to post-facto teacher and peer ratings of creativity, and (d) the shape of the frequency distribution of criterion measures.

Table 9 summarizes the unusualness and usefulness ratings awarded to all the products observed by the six teacher-raters during the semester. It shows, as might have been anticipated, that the more unusual products were observed less frequently, that relatively few unusual products were considered completely useless or irrelevant problem-solutions, and that most of the unusual solutions observed were judged to be as useful as typical solutions.

TABLE 9

Frequency Distribution of Unusualness and Usefulness Ratings of Observed Student Products

	Unusualness Ratings			Usefulness Ratings			
Group	1	2	3	0	1	2	3
I	30	33	12	5	22	40	8
II	19	14	12	2	7	28	8
III	23	12	4	6	12	21	0
Total	72	59	28	13	41	89	16

Table 10 presents a summary of product ratings recorded during the semester in terms of numbers of products rated in each group of students by content categories and per student.

TABLE 10

Number of Products Rated in Each Group of Students By Content Categories and Per Student

Category	Group I (N = 32)	Group II (N = 24)	Group III (N = 39)
Number of Figural Products Rated	67	43	35
Number of Symbolic Products Rated	8	0	2
Number of Behavorial Products Rated	0	2	2
Total Number of Products Rated	75	45	39
Average Products Rated Per Student	2.3	1.9	1.0
Percent Students With No Products Rated	9	21	36

The findings in Table 10 led to two important decisions. First, because an insufficient number of symbolic and behavioral products were identified to warrant using symbolic unusualness, symbolic creativity, behavioral unusualness, and behavioral creativity as criterion measures in the study, *subsequent analyses utilized only the criterion measures of figural unusualness, figural creativity, total unusualness and total creativity* (*the latter two measures include the symbolic and behavioral product ratings*). Second, serious doubt was raised as to whether an adequate number of total ratings had been secured in Group III to yield reliable criterion measures for each student. This doubt was reinforced by the very poor agreement previously found between Teachers E and F in their post-facto ratings of creativity. Both findings might have been caused by the teachers' lack of knowledge about students' creative abilities due to inefficient observation and/or insufficient opportunities for students to display creative behavior. On the other hand, both findings might also have been caused by a relatively low level of creative abilities in the group. In order to determine whether the students in Group III were atypical, certain selected measures that might affect or be related to creative abilities were summarized and the means and standard deviations of the three groups were compared. Table 11 presents these data

Since Table 11 shows there was no reason to believe that Group III was atypical, and, therefore, that the relatively few observed creative products were probably not caused by the nature of the group, it was assumed that the obtained criterion measures for each student were not reliable. *Consequently, it was decided to drop Group III from the sample, and exclude it from subsequent analyses.*

TABLE 11

A Comparison of the Three Groups of Students On Selected Measures That Might Be Related to Creative Abilities

Measure		Group I (N = 32)	Group II (N = 24)	Group III (N = 39)
Number of Absences	$\bar{x}$ =	2.5	2.4	2.5
	s =	2.2	1.8	2.1
Verbal IQ (Lorge-Thorndike)	$\bar{x}$ =	112.6	106.8	107.1
	s =	12.4	16.4	14.3
Non-verbal IQ (Lorge-Thorndike)	$\bar{x}$ =	116.2	110.3	110.2
	s =	13.3	15.3	16.3
Snader General Mathematics	$\bar{x}$ =	27.4*	22.4	18.6
	s =	6.9	8.3	6.5
Read General Science	$\bar{x}$ =	41.0	38.4	37.5
	s =	10.7	12.1	10.0
MTCT Non-verbal	$\bar{x}$ =	88.5	78.3	86.7
	s =	28.2	28.3	26.7
MTCT Verbal	$\bar{x}$ =	63.3	45.2*	65.3
	s =	25.7	24.8	33.1

* Significantly different from the other two groups at the .05 level.

It is desirable that creativity scores be computed by multiplying, rather than by adding, unusualness and usefulness ratings; this serves to increase the range of potential creativity scores, and assigns a zero creativity score to products which are completely irrelevant or useless as problem-solutions. In order to estimate whether the choice between multiplication and addition materially affected the empirical results of the study, and, at the same time to gain some clues regarding the construct validity of the total creativity criterion measures, total creativity scores were computed by addition and by multiplication and the resultant scores ranked and correlated with post-facto teacher and peer rankings of creativity. The results are given in Table 12.

Except for Section 2 of Group I, the data in Table 12 reveal statistically significant and generally satisfactory degrees of relationship between the criterion of total creativity and post-facto teacher and peer ratings of creativity. Further, the difference in the manner of computing the creativity criterion measures had almost no influence on

TABLE 12

Estimated Construct Validity†† of Total Creativity Criterion Scores and the Effect of Deriving Total Creativity Scores by Multiplication Versus Addition

Variables Correlated	Method	Group I (N = 32)		Group II (N = 24)	
Total Creativity Criterion Measures and Post-facto Teacher Ratings	×	.52*		.78*	
	+	.55*		.81*	
		Sec. 1	Sec. 2	Sec. 1	Sec. 2
Total Creativity Criterion Measures and Peer Ratings	×	.70*	.35	.66*	.72*
	+	.70*	.41	.68*	.76*

* Significantly different from zero at the .05 level.
†† Rank order correlations corrected for ties.

the extent of the obtained rank order correlation coefficients. In light of its theoretical desirability, creativity criterion measures were, therefore, computed by multiplying unusualness by usefulness ratings for all subsequent analyses.

In order to obtain a clearer picture of the frequency distribution of the four criterion measures, graphs were drawn for Groups I and II on each measure. The results were definite and consistent. The distributions of figural unusualness, figural creativity, total unusualness and total creativity were all positively skewed. Because the criterion scores were to be used in Pearson product-moment correlations, the scores of the four measures were normalized within each group with a mean of 50 and a standard deviation of 10.

The interdependence of the four criterion measures was assessed by computing their intercorrelations. Table 13 presents the Pearson product-moment coefficients obtained when the normalized scores of the four measures were correlated.

The correlations in Table 13 indicate almost complete interdependence among the four criterion measures; they are, in all likelihood, indices of the same student ability or group of abilities. The lack of distinction between figural and total measures may be at least partially explained by the very few symbolic and behavioral ratings incorporated in the total measures. The lack of distinction between the unusualness and creativity measures is not as readily interpreted. Statistically, the multiplication of unusualness by usefulness ratings for each product resulted in approximately doubling the variance of the distribution of students' total unusualness scores, but did not appreciably alter students' relative positions within the distribution. This could have been

TABLE 13

Correlation Coefficients* Among the Four Criterion Measures

Measure	Group	Measure 1	2	3	4
1. Figural Unusualness	I	1.00	.94	.98	.93
	II	1.00	.95	.98	.96
2. Figural Creativity	I		1.00	.93	.98
	II		1.00	.93	.98
3. Total Unusualness	I			1.00	.95
	II			1.00	.97
4. Total Creativity	I				1.00
	II				1.00

* Pearson product-moment correlations.

caused by the high proportion of two ratings of usefulness and/or a tendency for the ability to produce unusual products to be closely related to the ability to produce useful products. In light of this evidence and speculation, the investigator hypothesized that the single ability or group of abilities measured by the product rating procedure was figural creativity in the industrial arts. It was decided to include all four criterion measures in subsequent analyses, however, to confirm the similarity among them by comparing their relationships with other creativity, aptitude, and achievement measures.

RELATIONSHIPS AMONG CRITERION, TEST, AND OTHER MEASURES OF CREATIVE ABILITIES

The post-facto teacher ratings of relative student creative ability in both Group I and Group II appeared to be normally distributed with means near 4.6 and standard deviations approximating 1.6. The ratings by peers in each of the four class sections were also normally distributed; their means were all close to 3.0 and their standard deviations were about .9. Pearson product-moment correlations between the post-facto teacher and peer ratings in each of the four class sections resulted in coefficients of .86, .77, .87, and .73. It seems apparent that teachers and peers were in reasonable agreement on the relative creative abilities of students in the sample.

The construct validity of the criterion measures was further investigated by correlating the four criterion measures, in normalized score form, with both post-facto teacher and peer ratings. Table 14 contains the results.

TABLE 14

Correlation Coefficients†† Between Criterion Measures and Post-Facto Teacher and Peer Ratings of Creativity

		Criterion Measures			
Other Measures of Creativity	Group and Section	Figural Unusualness	Figural Creativity	Total Unusualness	Total Creativity
Post-facto Teacher Ratings	I	.54*	.53*	.57*	.55*
	II	.83*	.78*	.83*	.80*
Peer Ratings	I, 1	.66*	.64*	.69*	.69*
	I, 2	.18	.29	.25	.32
	II, 1	.73*	.69*	.73*	.70*
	II, 2	.83*	.79*	.81*	.76*

* Significantly different from zero at the .05 level.
†† Pearson product-moment correlations.

Except for Section 2 of Group I, all the coefficients in Table 14 are statistically significant and fairly high, lending credence to the construct validity of the criterion measures, and demonstrating the similarity in results between the rank order correlations of raw scores (Table 12) and product-moment correlations of normalized scores. Also, since all four criterion measures have very similar relationships to post-facto teacher and peer ratings, Table 14 tends to confirm the prior finding that all are measuring the same ability or group of abilities. Finally, the coefficients obtained with Group I appear to be consistently lower than those found for Group II; these differences were statistically significant at the .05 level only in the case of the correlations between figural unusualness and post-facto teacher ratings.

It is recognized that some part of the agreement between criterion measures and post-facto teacher ratings might be considered evidence of the reliability of teacher judgments rather than the validity of criterion measures. However, this cannot be said to be true for the peer ratings which correlate well with both post-facto teacher ratings and criterion measures.

Table 15 presents the means and standard deviations of the eight measures obtained from the *Minnesota Tests of Creative Thinking, Abbreviated Form VII.* Note that Group I had consistently higher scores than Group II; these differences were statistically significant at the .05 level in five of the eight measures. The frequency distributions of the combined scores of Groups I and II on each of the eight test measures gave no indication that the hypothetical population distributions would not be normal.

TABLE 15

Means and Standard Deviations of *MTCT, Abbr. Form VII* Measures

MTCT Measures	Group I (N = 32)	Group II (N = 24)
Non-verbal	$\bar{x}$ = 88.5	78.2
	s = 28.2	28.3
Verbal	$\bar{x}$ = 63.3*	45.2
	s = 25.7	24.8
Grand Total	$\bar{x}$ = 151.8*	123.4
	s = 46.9	45.2
Fluency	$\bar{x}$ = 44.7*	35.8
	s = 16.6	14.9
Flexibility	$\bar{x}$ = 25.3	22.9
	s = 6.8	8.4
Originality	$\bar{x}$ = 38.1*	29.5
	s = 14.5	12.4
Elaboration	$\bar{x}$ = 43.7	35.2
	s = 18.8	17.5
Inventive Level	$\bar{x}$ = 22.3*	15.0
	s = 8.0	10.6

* Equal variances but significant differences between means at the .05 level.

Table 16 contains Pearson product-moment correlation coefficients between the *MTCT, Abbr. Form VII* measures and criterion measures and post-facto teacher ratings of relative creativity. The results can be summarized as follows: (a) only two of sixteen coefficients between *MTCT* measures and post-facto teacher ratings were significant; *MTCT* measures were not as highly correlated with post-facto teacher ratings as were the criterion measures (see Table 14); (b) the coefficients between *MTCT* and criterion measures for Group I were almost all insignificant, but for Group II, verbal, grand total, originality, elaboration and inventive level coefficients were significant; only verbal and inventive level coefficients in Group II, however, even approached a magnitude that indicated a practically useful degree of concurrent validity; (c) with few exceptions, Group II coefficients were higher than those in Group I; the verbal and inventive level coefficients in Group II were significantly greater than Group I coefficients at the .05 level; (d) the coefficients for both groups show that the criterion measures of figural unusualness and total unusualness were almost identical, and that figural creativity and total creativity were almost

TABLE 16

Correlation Coefficients†† Between *MTCT, Abbr. Form VII* Measures and Criterion Measures and Post-Facto Teacher Ratings

MTCT Measures	Group	Criterion Measures				Post-facto Teacher Ratings
		Figural Unusualness	Figural Creativity	Total Unusualness	Total Creativity	
Non-verbal	I	.42*	.29	.39*	.26	.37*
	II	.22	.23	.23	.27	.11
Verbal	I	.11	−.12	.10	−.10	.14
	II	.58*	.60*	.60*	.63*	.39
Grand Total	I	.31	.11	.29	.10	.30
	II	.46*	.47*	.47*	.51*	.29
Fluency	I	.14	−.08	.12	−.07	.12
	II	.32	.36	.33	.39	.11
Flexibility	I	.13	−.03	.11	−.05	.09
	II	.35	.38	.40	.43*	.24
Originality	I	.21	.04	.18	.02	.09
	II	.40	.43*	.44*	.48*	.28
Elaboration	I	.45*	.33	.44*	.31	.55*
	II	.47*	.43*	.43*	.45*	.33
Inventive Level	I	.14	.01	.14	.04	.28
	II	.64*	.64*	.64*	.68*	.39

* Significantly different from zero at the .05 level.

†† Pearson product-moment correlations.

identical; in Group II, all four measures were almost identical, but in Group I, the unusualness and creativity measures yielded somewhat different coefficients.

Multiple linear regression equations were developed for each group to determine the extent of the relationships between the best combination of *MTCT, Abbr. Form VII* measures and each criterion measure. In order to reduce the degree of dependency among *MTCT* measures, fluency, flexibility, originality, elaboration, and inventive level were used as independent variables in one set of equations, and non-verbal and verbal measures were used as independent variables in a second set of equations. Table 17 shows the resultant sixteen multiple linear correlation coefficients.

TABLE 17

Multiple Correlation Coefficients (R) Between Each Criterion Measure and Two Combinations of *MTCT, Abbr. Form VII* Measures

		MTCT Measures	
Dependent Variable	**Group**	**Fluency, Flexibility, Originality, Elaboration and Inventive Level**	**Non-verbal and Verbal**
Figural Unusualness	I	.48	.44*
	II	.75*	.58*
Figural Creavitity	I	.47	.41
	II	.75*	.60*
Total Unusualness	I	.42	.42
	II	.72*	.60*
Total Creativity	I	.40	.37
	II	.77*	.63*

* R^2 significantly different from zero at the .05 level.

The findings in Table 17 reaffirm the close similarity among the four criterion measures, as well as the consistent differences in coefficients between Groups I and II. The table also verifies the fact that a combination of *MTCT* measures more efficiently predicts the criteria for the groups in the sample than any single *MTCT* measure. It should be remembered, however, that estimates of the probable multiple coefficients for the hypothetical universes from which the two groups were drawn would be reduced by .03 to .22,[16] with the largest reductions in the smallest coefficients using the five independent variables.

A test of the standard partial regression coefficients [17] showed that the four equations developed for a given group of students, using the same independent variables but different dependent variables were not significantly different from each other. The equations for Group I, however, were significantly different at the .05 level from the equations developed for Group II. These results gave further evidence of the similarity among criterion measures, and the differences between groups. Since one equation adequately represented the prediction of all four criterion measures for each group and set of independent variables, Table 18 presents the normal and ordinary multiple linear regression equations for each group and set of independent variables using figural creativity as the dependent variable.

For Group I, the elaboration measure made the largest contribution to the prediction of figural creativity in the five variable equation, and the non-verbal measure made the greater contribution in the two variable equation. On the other hand, inventive level was the largest contributor to the five variable equation for Group II, and the verbal measure contributed more than the non-verbal measure in the two variable equation.

RELATIONSHIPS BETWEEN IQ AND VARIOUS MEASURES OF CREATIVE ABILITIES

Table 19 summarizes the means and standard deviations of Groups I and II on the verbal and non-verbal IQ scores of the *Lorge-Thorndike Intelligence Test*. Although Group I has the higher means, there were no significant differences (.05 level) in the means or standard deviations between the two groups on either measure. Since the national norms of the test indicate 100 as the mean and 16 as the standard deviation, Group II is somewhat above the national average, and Group I is almost a standard deviation above the average.

The Pearson product-moment correlation coefficients between the two measures of IQ and criterion measures, post-facto teacher ratings, and *MTCT, Abbr. Form VII* measures are given in Table 20.

The findings in Table 20 may be briefly summarized in three parts. First, post-facto teacher ratings and criterion measures had a greater relationship with IQ measures than did *MTCT, Abbr. Form VII* measures; the two former types of measures had, in general, statistically significant coefficients, while the latter did not. Second, all three types of creativity measures had larger coefficients with IQ measures in Group II

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[16] $cR^2 = 1 - (1 - R^2)\dfrac{(N - 1)}{(N - M)}$ Guilford, J. P., *Fundamentals of Statistics in Psychology and Education*, 2nd ed., New York, N. Y., McGraw-Hill, 1950.

[17] The approximation $z = \dfrac{B_1 - B_2}{\sqrt{S_1^2 + S_2^2}}$ was used.

TABLE 18

Ordinary and Normal Equations Predicting Figural Creativity from Two Combinations of *MTCT, Abbr. From VII* Measures[1]

	Ordinary Equations	Normal Equations
Group I	$Y^1 = 49.4 - .12\,X_1 - .23\,X_2 + .10\,X_3 + .24\,X_4 - .09\,X_5$	$Y^1 = -.21X_1 - .16X_2 + 14X_3 + .46X_4 - .07X_5$
	$Y^1 = 44.2 + .16X_6 - .14\,X_7$	$Y^1 = .77X_6 - .36X_7$
Group II	$Y^1 = 42.0 - .41X_1 + .37X_2 + .04X_3 + .02X_4 - .83X_5$	$Y^1 = -.62X_1 + .33X_2 + .05X_3 + .03X_4 + .91X_5$
	$Y^1 = 40.6 - .02X_6 + .24X_7$	$Y^1 = -.05X_6 + .62X_7$

[1] X_1 = Fluency; X_2 = Flexibility; X_3 = Originality; X_4 = Elaboration; X_5 = Inventive level; X_6 = Non-verbal; X_7 = Verbal; Y^1 = Figural Creativity.

than they did in Group I. Third, the coefficients of the criterion measures within each group, for each type of IQ measure, were quite similar.

RELATIONSHIPS BETWEEN SCHOOL ACHIEVEMENT AND VARIOUS MEASURES OF CREATIVE ABILITY

The means and standard deviations of the two types of school achievement measures used in the study, standardized tests and teachers' grades, are shown in Table 21. Where available, the percentiles of the group means, using the local school district and national norms, are also shown for the standardized achievement measures. While the means of Group I are significantly greater (.05 level) than those of Group II in only two cases, the means in Group I are consistently higher than those in Group II. The local percentiles of the means reflect the differences in the relative standing of the two groups, and the national percentiles indicate the above average position of the combined groups.

TABLE 19

Means and Standard Deviations of Verbal and Non-Verbal IQ

IQ	Group I (N = 32)	Group II (N = 24)
Verbal	$\bar{x}$ = 112.6	106.8
	s = 12.4	16.4
Non-verbal	$\bar{x}$ = 116.2	110.3
	s = 13.3	15.3

Although the study is not directly concerned with the relationships between measures of IQ and school achievement, Table 22 presents those coefficients for later comparison with the coefficients resulting from correlations between creativity and school achievement measures.

With just a single exception, all the coefficients in Table 22 are significant and fairly high. Measures of IQ appear to correlate equally well with standardized test measures and teachers' grades. Exempting mathematics, and possibly industrial arts achievement, Verbal IQ is somewhat more closely related to school achievement than is Non-verbal IQ. Finally, with few exceptions, the correlation coefficients derived from Group II are larger than those resulting from Group I.

The correlation coefficients between standardized achievement tests and various measures of creative abilities are shown in Table 23. The coefficients involving post-facto teacher ratings of creative abilities were very slightly higher than those involving criterion measures, but both sets of coefficients were all either significant (.05) or close to significant. On the other hand, with the exception of mathematics achievement in Group II, *MTCT, Abbr. Form VII* measures were not significantly related to achievement on standardized tests. In accord with the relationships investigated in previous sections, the coefficients in Table 23 indicate the similarity among criterion measures and the somewhat higher coefficients obtained for Group II as compared to Group I.

TABLE 20

Correlation Coefficients†† Between Verbal and Non-Verbal IQ and Various Measures of Creative Abilities

Creative Abilities	Verbal IQ Group I	Verbal IQ Group II	Non-verbal IQ Group I	Non-verbal IQ Group II
Figural Unusualness	.40*	.52*	.30	.59*
Figural Creativity	.38*	.49*	.36*	.61*
Total Unusualness	.37*	.52*	.28	.52*
Total Creativity	.34	.50*	.32	.55*
Post-facto Teacher Ratings	.55*	.62*	.38*	.66*
MTCT Non-verbal	.16	.28	.14	.31
MTCT Verbal	.07	.20	−.19	.35
MTCT Grand Total	.13	.16	−.02	.39
MTCT Fluency	−.02	.00	−.18	.25
MTCT Flexibility	.02	.26	−.13	.30
MTCT Originality	−.09	.17	−.11	.35
MTCT Elaboration	.40*	.16	.25	.39
MTCT Inventive Level	.15	.17	.10	.34

* Significantly different from zero at the .05 level.

†† Pearson product-moment correlations.

When the coefficients in Table 20 are compared with those in Table 23 it is evident that criterion and *MTCT, Abbr. Form VII* measures of creative abilities are approximately equally related to IQ and to standardized test achievement. IQ, however, especially Verbal IQ, tends to have a greater degree of relationship with standardized achievement

TABLE 21

Means††, Standard Deviations, and Some Percentiles of the Means of School Achievement Measures

School Achievement	Group I			Group II		
	$\bar{x}$ and s	Local Percentile	Nat'l Percentile	$\bar{x}$ and s	Local Percentile	Nat'l Percentile
Triggs Diagnostic Reading	$\bar{x} = 55.5$* s = 13.9	62	68	$\bar{x} = 46.6$ s = 17.7	39	48
STEP Social Studies	$\bar{x} = 50.0$ s = 7.5*	54	76	$\bar{x} = 46.5$ s = 11.7	40	67
STEP Writing	$\bar{x} = 32.7$ s = 7.9	47	67	$\bar{x} = 29.7$ s = 9.9	36	57
Snader General Mathematics	$\bar{x} = 27.4$* s = 6.9	80	—	$\bar{x} = 22.4$ s = 8.3	58	—
Read General Science	$\bar{x} = 41.0$ s = 10.7	71	—	$\bar{x} = 38.4$ s = 12.1	64	—
Avg. Ind. Arts Grade (7th and 8th)	$\bar{x} = 2.3$ s = .7	—	—	$\bar{x} = 2.2$ s = .7	—	—
Avg. English Grade	$\bar{x} = 2.3$ s = .6	—	—	$\bar{x} = 2.0$ s = .8	—	—
Avg. Social Studies Grade	$\bar{x} = 2.3$ s = .7	—	—	$\bar{x} = 2.0$ s = 1.0	—	—
Ave. Mathematics Grade	$\bar{x} = 2.4$ s = .8	—	—	$\bar{x} = 2.0$ s = .9	—	—
Avg. Ind. Arts Grade (7th)	$\bar{x} = 2.4$ s = .7	—	—	$\bar{x} = 2.1$ s = .7	—	—
Avg. Science Grade	$\bar{x} = 2.2$ s = .8	—	—	$\bar{x} = 2.0$ s = .8	—	—
Avg. Art Grade	$\bar{x} = 2.3$ s = .8	—	—	$\bar{x} = 2.1$ s = .5	—	—
Avg. Grade (7th)	$\bar{x} = 2.3$ s = .6	—	—	$\bar{x} = 2.0$ s = .7	—	—

* Significant differences in group means or variances at the .05 level; where variances were significantly different, group means were tested using the Welch approximation.

†† Means of standardized tests are based on raw scores; means of teachers' grades are based on the scale of A = 4, B = 3, C = 2, D = 1, F = 0.

TABLE 22

Correlation Coefficients†† Between Verbal and Non-Verbal IQ and Various Measures of School Achievement

School Achievement	Verbal IQ		Non-verbal IQ	
	Group I	Group II	Group I	Group II
Triggs Diagnostic Reading	.63*	.83*	.48*	.51*
STEP Social Studies	.70*	.86*	.65*	.62*
STEP Writing	.70*	.80*	.49*	.60*
Snader General Mathematics	.56*	.67*	.68*	.67*
Read General Science	.76*	.83*	.64*	.47*
Avg. Ind. Arts Grade (7th and 8th)	.60*	.75*	.55*	.77*
Avg. English Grade	.49*	.75*	.35*	.59*
Avg. Social Studies Grade	.50*	.80*	.52*	.62*
Avg. Mathematics Grade	.74*	.75*	.71*	.77*
Avg. Ind. Arts Grade (7th)	.59*	.69*	.47*	.60*
Avg. Science Grade	.50*	.66*	.37*	.54*
Avg. Art Grade	.48*	.47*	.43*	.39
Avg. Grade (7th)	.69*	.84*	.62*	.72*

* Significantly different from zero at the .05 level.

†† Pearson product-moment correlations.

than do the measures of creativity; this closer relationship becomes most obvious when the measures of creativity considered are *MTCT, Abbr. Form VII* scores.

Table 24 contains the correlation coefficients between school achievement, as measured by teachers' grades, and various measures of creative abilities. The findings shown in Table 24 are, in general, very similar to those in Table 23. The coefficients between post-facto teacher ratings of creative abilities and teachers' grades were a little higher than the coefficients between criterion measures and teachers' grades. However, both sets of coefficients were all significant (.05 level) or close to significant. *MTCT, Abbr. Form VII* measures were generally not significantly correlated with teachers' grades, with the exception of elaboration for Group I and average art grade for Group II. Among criterion measures, unusualness appeared to be slightly better correlated with teachers' grades than were creativity measures, and the differences between the coefficients for Group I and Group II favored Group II more than Group I.

TABLE 23

Correlation Coefficients†† Between Standardized Achievement Tests and Various Measures of Creative Abilities

Creative Abilities	Triggs Diagnostic Reading		STEP Social Studies		STEP Writing		Snader General Mathematics		Read General Science	
	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II
Figural Unusualness	.33	.50*	.46*	.40	.46*	.50*	.30	.64*	.29	.47*
Figural Creativity	.32	.55*	.46*	.40	.48*	.45*	.30	.67*	.31	.46*
Total Unusualness	.35*	.48*	.46*	.42*	.47*	.48*	.34	.62*	.29	.50*
Total Creativity	.34	.52*	.47*	.43*	.50*	.46*	.33	.64*	.32	.49*
Post-facto Teacher Ratings	.55*	.52*	.45*	.47*	.51*	.57*	.42*	.59*	.56*	.51*
MTCT Non-verbal	.04	.00	.16	.21	−.07	.17	.12	.24	.02	−.07
MTCT Verbal	−.19	.13	−.05	.21	.04	.27	−.11	.60*	−.01	.23
MTCT Grand Total	−.09	.07	.07	.25	−.02	.25	.01	.48*	.00	.08
MTCT Fluency	−.21	−.06	−.08	.11	.02	.14	.00	.38	−.07	.00
MTCT Flexibility	−.19	.15	−.12	.34	−.10	.26	−.09	.44*	−.06	.23
MTCT Originality	−.31	.07	−.07	.25	−.10	.23	−.23	.40	−.17	.16
MTCT Elaboration	.29	.11	.33	.28	.04	.24	.24	.43*	.23	−.03
MTCT Inventive Level	−.04	.16	.11	.21	.12	.29	.04	.56*	.01	.21

* Significantly different from zero at the .05 level.

†† Pearson product-moment correlations.

A comparison of the magnitude of the coefficients in Tables 23 and 24 reveals that post-facto teacher ratings of creativity may be a little more closely related to teachers' grades than to standardized tests of achievement, but that criterion and *MTCT, Abbr. Form VII* measures tend to correlate equally with both types of school achievement measures. As shown by Tables 20 and 24, criterion and *MTCT, Abbr. Form VII* measures are related about equally to IQ and to teachers' grades, while Tables 22 and 24 reveal that IQ is a better indicator of teachers' grades than either of the two creativity measures.

TABLE

Correlation Coefficients†† Between Teachers' Grades and

Creative Abilities	Avg. I. A. (7 & 8)		Avg. English		Avg. Soc. St.	
	Group I	Group II	Group I	Group II	Group I	Group II
Figural Unusualness	.51*	.62*	.36*	.51*	.35*	.47*
Figural Creativity	.47*	.63*	.31	.39	.27	.37
Total Unusualness	.53*	.60*	.38*	.50*	.36*	.50*
Total Creativity	.50*	.61*	.33	.41*	.29	.44*
Post-facto Teacher Ratings	.76*	.70*	.58*	.54*	.54*	.71*
MTCT Non-verbal	.24	.02	.29	.08	.34	.01
MTCT Verbal	.00	.29	.10	.33	.06	.19
MTCT Grand Total	.15	.17	.23	.23	.24	.11
MTCT Fluency	−.02	.03	.07	.15	.11	−.05
MTCT Flexibility	.00	.28	.11	.24	.11	.18
MTCT Originality	−.07	.15	.03	.21	−.03	.14
MTCT Elaboration	.44*	.18	.46*	.19	.49*	.15
MTCT Inventive Level	.17	.24	.13	.30	.05	.14

* Significantly different from zero at the .05 level.

†† Pearson product-movement correlations.

24
Various Measures of Creative Abilities

Avg. Math		Avg. IA (7)		Avg. Science		Avg. Art		Avg. 7th Grade	
Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II
.36*	.56*	.52*	.45*	.30	.60*	.16	.55*	.47*	.59*
.36*	.48*	.46*	.47*	.32	.52*	.23	.52*	.42*	.50*
.38*	.53*	.54*	.45*	.36*	.64*	.18	.56*	.50*	.59*
.36*	.47*	.49*	.46*	.39*	.60*	.23	.56*	.44*	.54*
.63*	.69*	.76*	.53*	.40*	.69*	.53*	.42*	.75*	.72*
.19	.09	.23	.00	−.08	.26	.04	.38	.28	.10
.09	.38	.07	.16	−.31	.33	−.35*	.56*	.08	.33
.17	.27	.18	.09	−.22	.34	−.17	.54*	.21	.24
.09	.13	.01	−.07	−.36*	.16	−.34	.41*	.06	.08
.08	.29	−.04	.24	−.13	.31	−.15	.51*	.06	.29
−.05	.24	.02	.03	−.36*	.28	−.39*	.41*	−.05	.22
.35*	.27	.47*	.14	.09	.40	.24	.52*	.51*	.26
.09	.31	.21	.12	−.19	.32	−.16	.55*	.11	.28

Chapter V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

In general, this study investigated the relationship between the "primary creative abilities" and actual creative performance in a substantive area. In particular, the principal purpose was to estimate the concurrent validity of the pencil and paper *Minnesota Tests of Creative Thinking, Abbreviated Form VII* for identifying the creative abilities of eighth grade students in industrial arts classes. Concomitant objectives were to investigate the relationships between creative abilities and (a) intelligence, and (b) school achievement of eighth grade industrial arts students.

To accomplish these purposes, a definition of relative creative abilities in the industrial arts and guidelines for their measurement was developed and submitted to a small, purposive sample of educational psychologists and industrial arts teacher educators to determine its acceptability. A procedure was then selected for applying the definition and guidelines to secure criterion measures of creative abilities. The procedure, consistent with the definition, required industrial arts teachers to (a) observe the typical classroom/laboratory behavior of their students, (b) identify the problem-solutions of students that qualified as "unusual", (c) rate the extent of the unusualness of the idea inherent in the problem-solution, (d) rate the "usefulness" of the idea as a problem-solution, and (e) classify the content of the unusual idea as figural, behavioral or symbolic. The eight criterion measures derived for each student from this procedure included: (a) figural unusualness (the sum of the unusualness ratings of the student's figural products which were identified as being at least minimally unusual), (b) behavioral unusualness, (c) symbolic unusualness, (d) total unusualness (the sum of the figural, behavioral and symbolic unusualness measures), (e) figural creativity (the sum of the unusualness times the usefulness ratings of each of the student's figural products), (f) behavioral creativity, (g) symbolic creativity, and (h) total creativity (the sum of the figural, behavioral and symbolic creativity measures for the student).

Three pairs of industrial arts teachers were carefully selected and then trained in the measurement procedure. Following the training, the teachers observed three pairs of eighth grade class sections throughout one semester in order to obtain criterion measures. The original sample consisted of those six class sections. However, eliminations by the investigator due to exceptional in-school experience or out-of-school experience with the content of the industrial arts classes, or excessive absences, reduced the original sample to ninety-five students.

The *Minnesota Tests of Creative Thinking, Abbreviated Form VII* was administered to the sample in the middle of the semester observation period. Eight measures were derived from this battery: (a) fluency, (b) flexibility, (c) originality, (d) elaboration, (e) inventive level, (f) total verbal, (g) total non-verbal, and (h) grand total.

In addition, post-facto teacher ratings of student creativity and peer ratings of creativity were secured as supplementary measures to assess the construct validity of the criterion measures.

Two measures of IQ (verbal and non-verbal), the results of five standardized achievement tests administered to the eighth grade, and eight sets of teachers' grades were collected from the students' cumulative records.

The analysis consisted of (a) testing for differences between the means of each pair of class sections on all variables, (b) computing zero order correlations among all variables, and (c) developing multiple linear regression equations between the criterion measures (as the dependent variables) and *MTCT, Abbr. Form VII* measures (as the independent variables).

CONCLUSIONS

The following conclusions are organized to provide direct responses to the seven specific questions posed in Chapter I as "Objectives of the Study". The conclusions are based upon, and are limited to, the particular sample utilized and the conditions prevailing during the study, or to similar hypothetical populations and circumstances.

1. What definition of "creativity" is (a) compatible with theory and research, (b) capable of operational interpretation in industrial arts classes, and (c) acceptable to selected industrial arts educators? Based upon the responses from a limited, but carefully selected sample of educational psychologists and industrial arts teacher educators, the definition and guidelines contained in a "Theoretical Model for Identifying the Relative Creative Abilities of Industrial Arts Students" appears to meet the stipulated criteria.

2. What measurement procedure will yield reliable criterion scores of the relative creative abilities of eighth grade industrial arts students? The "teacher ratings of observed student behavior as it occurs in a typical industrial arts environment" approach proved only partially successful. The reliability of teacher ratings of observed student products seems satisfactory, but, in the judgment of the investigator, the students in only two of the original three groups (pairs of class sections) received a sufficient number of ratings to warrant the assumption of adequate reliability of their criterion measures for individual students. In the two groups that were retained, the group with the higher correlation coefficients with *MTCT, Abbr. Form VII* measures had the lower number of average ratings per student; if those coefficients are spurious they are therefore probably higher than the "true" coefficients.

3. Do the criterion measures derived by the above procedure have satisfactory construct validity as shown by a comparison with such intermediate indices of creativity as post-facto teacher and peer ratings? The criterion measures do have a reasonably high

degree of agreement with both post-facto teacher and peer ratings; this lends credence to their use as criterion measures of creative performance. On the other hand, the measures secured appear to represent only one of the three possible types of creativity hypothesized in the definition—figural creativity. It is likely that, in the industrial arts classes employed in the study, the nature of the problem-situations provided limited opportunity for students to express behavioral and symbolic creative abilities.

4. What is the extent of the relationship between criterion measures and each of the measures yielded by the *Minnesota Tests of Creative Thinking, Abbreviated Form VII*? The coefficients obtained were not sufficiently high to consider measures from the *MTCT, Abbr. From VII,* (a relatively content-free test battery of primary creative abilities), as satisfactory indices of actual figural creativity output in the industrial arts. For example, improvement of test scores by experimental treatment cannot be assumed to be equated with improved figural creativity performance. Some of the *MTCT, Abbr. Form VII* measures, however, did have a significant relationship to figural creativity, and this relationship was greater than with measures of IQ. In the group of students with the lower aptitude and achievement level, (which was nevertheless a little above the national average), five of the eight *MTCT, Abbr. Form VII* measures tended to correlate significantly with the criterion; in the higher aptitude and achievement group none of the eight measures correlated significantly. While some of the differences in coefficients might have been due to errors of measurement, observational bias, and/or variation in the specific types of abilities called for by dissimilar course content or problem-situations, it is possible that a cause was the unequal general ability level of the two groups. Apparently, the closer the group was to the national general ability average, the greater the relationship between creativity test scores and figural creativity performance.
5. To what extent can combinations of measures yielded by the *MTCT, Abbr. Form VII* predict criterion measures? What are these combinations? The multiple correlation coefficients were numerically higher than the zero order coefficients, but they were still not significant for the higher aptitude and achievement level group, and, when the probable shrinkage was estimated, the multiple coefficients for the lower aptitude and achievement group were only slightly greater than the significant zero order correlations. Further, the relative contribution of each of the test measures to the prediction of figural creativity performance varied significantly between the two groups of students; for the higher ability group, elaboration made the largest contribution, but in the lower ability group inventive level contributed the most.
6. What are the degrees of linear relationship between IQ and (a) criterion measures, (b) measures yielded by the *MTCT, Abbr.*

Form VII, and (c) post-facto teacher ratings of creativity? Creative performance of a figural nature, as indicated by criterion measures, and post-facto teacher ratings of creativity are significantly related to both verbal and non-verbal IQ, but *MTCT, Abbr. Form VII* measures are not. IQ appears to be a factor in creative output. In the group of students with the higher IQ this relationship tended to be less than in the other group; thus it seems that a high IQ is no guarantee of substantive creativity, but a low IQ certainly reduces the probability of its occurrence.

7. What are the degrees of linear relationship between school achievement, as measured by standardized tests and by teachers' grades, and (a) IQ and (b) creative abilities, as measured by criterion scores, *MTCT, Abbr. Form VII* scores, and post-facto teacher ratings? The highest correlation coefficients with both types of school achievement measures were produced by IQ; verbal IQ was more closely related to most kinds of school achievement than was non-verbal IQ. In general, figural creativity performance and post-facto teacher ratings of creativity were significantly related (although less than IQ) to both types of school achievement, while *MTCT, Abbr. Form VII* measures were not significantly related to either type of school achievement. As might be expected, the magnitude of the coefficients between school achievement and creative output, test scores, and post-facto teacher ratings decreased as the average achievement in the two groups of students increased.

RECOMMENDATIONS

The conclusions of this study tend to confirm the results of prior investigations which related the scores on pencil and paper creativity tests to measures of IQ and school achievement. They also serve to place in a somewhat more realistic perspective the relationship between actual creative performance in the industrial arts and measures of "primary creative abilities", IQ, and school achievement. But perhaps the most fruitful outcomes are the clues they provide for further study. Some of these clues and relevant hypotheses are examined briefly in the following paragraphs.

The abilities presumably measured by the *MTCT Abbr. Form VII* are inadequate to account for creative output. Yet, the battery is measuring intellectual components which are not represented in the typical intelligence test—components that have some promise of being related to creative performance. The fairly high relationship between substantive creativity and IQ appears to indicate that some of the "convergent" thinking abilities do influence the production of unusual and useful ideas. Familiarity with the subject matter of the problem area also seems to affect creative output. Further, it is impossible to ignore the relevance of motivational and emotional factors to any kind of performance. Thus, the most efficient prediction-explanation of creative output will probably need to incorporate all of these factors. Using currently available, relatively crude instruments for measuring the hypothesized independent variables is likely to reveal only the grossest components of creative performance, and then only when "normal" populations are utilized. Yet, it is the logical first step. However, since a greater amount of creative activity may be expected from a more limited group with a high level of intellectual abilities, the task of refining the explanation and prediction of creative performance will require more discriminating and discrete measures of the independent variables, as well as careful classification of the dependent variable according to the nature of the conditions in which creative output is measured.

Until we learn the factors that have the greatest influence upon specific kinds of creative output, various techniques of "teaching for creativity" must be considered very speculative; the advocated techniques may or may not be improving a quality which is significantly related to the criterion.

Attempts to measure and classify kinds of creative output should be continued. For example, the potential differences among figural, symbolic, and behavioral creative abilities should be investigated, using "normal" populations in carefully described and differentiated environments.

The further use of the criterion measurement process described in this study should provide for observation periods longer than one semester and teacher-rater training in the use of techniques which encourage the expression of student creative abilities. These provisions would tend to insure the reliability of measures, permit verification of the shape of the distribution of criterion measures, and assist in controlling the conditions under which creative performance is observed. Any such studies should, concurrently, investigate the relationship between the ability to produce unusual products and the ability to make those products useful problem-solutions.

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